Performing Different Selection Strategies on Dejong Functions

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Abstract— Genetic algorithms are searching and optimization techniques that can be applied in many problems like mathematical optimization and simulation parameterization. Mainly genetic algorithm is used in optimization problems like travelling salesman problem (TSP), dejong function etc. Selection operator is an important operator of genetic algorithm. Selection is a method that randomly picks chromosomes out of the population according to their evaluation function. The higher the fitness function, the more chance an individual has to be selected. In this paper researcher implements various dejong functions (Rastrigin’s function, dejong function1, Axis parallel hyper-ellipsoid) with the help of matlab code. Results are described by the formulation of graphs and tables. The selection technique which is used in the dejong function are roulette wheel selection and rank selection. With these selection schemes results of the dejong functions (Rastrigin’s function, dejong function1,Axis parallel hyper-ellipsoid) are calculated and compared. The aim of this paper is to show the minimum values of dejong function at different generations.

Key words: Dejong Function, Rank Selection, Genetic Algorithm, Roulette Wheel Selection

I. INTRODUCTION

Genetic algorithms are search techniques based on principles of natural selection and genetics. Genetic algorithms were initially proposed by Holland in 1960s and 1970s. GAs attracted many researchers to search and optimize complex problems. In genetic algorithm encoding of Chromosomes are our first step to solve any problem. Genetic algorithm is also dependent on the fitness function. The fitness functions find out the quality of solution. The main reason to use the genetic algorithm because there are multiple local optima. Selection operator identifies the good solution in a population[1]. The selection of individuals for the production of the next generation is a critical process in GA. The individuals that are chosen for reproduction and the number of children each selected individual produces are determined by the selection mechanism[2]. It is also called reproduction operator. In reproduction operator we cannot create the new string. GA process can be started to evolve solutions to the search problem by using the following steps:

A. Initialization:
The initial population of candidate solutions (chromosomes) is usually generated randomly from the search space.

B. Evaluation:
In this step the fitness values of the candidate solutions are evaluated by using the fitness function.

C. Selection:
Selection is the process in which the chromosomes are randomly selected from the population according to their evaluation function. Selection of an individual is directly proportional to their fitness function. Selection of an individuals in the population is fitness dependent[3]. Many selection procedures have been proposed by different researchers including roulette-wheel selection, stochastic universal selection, rank based selection and tournament based selection.

D. Recombination:
In this step parents have been selected and recombined to generate children.

E. Mutation:
While recombination operates on two or more chromosomes, it locally but randomly modifies a solution. Again, there are many different variations of mutation, but it usually involves one or more changes being made.

F. Replacement:
The new population created by selection, recombination, and mutation replaces the original chromosomes in the parental population.

G. Repeat steps:
2–6 until a terminating criteria does not satisfied.

Fig. 1: steps of G.A

The remainder part of this paper is organized as follows: Section 2 presents a brief review of related work on different dejong functions. Selection 3 presents a brief description of problem formulation. Section 4 describes in detail the selection methods that are used in the experiments. Section 5 tests the performance of GA and discusses the experimental results. The Paper is concluded in section 6.

II. RELATED WORK

De Garis proposed an iterative scheme [4] to involving a Sequence of fitness functions. A randomly initialized
population is evolved by GA using the first fitness the resulting population is used as the initial population for a GA using the second fitness and so on. (schoenauer & Xanthakis 1993) used that idea for constrained optimization problems. In these works, the idea is purposely bias the initial population of the GA, but the tool is another GA. However this approach is highly problem specific, and requires from the user the design of appropriate sequence of fitness functions. John J. Grenfenstette has used genetic algorithms to find optimal parameters of genetic algorithm [5]. A paper by Ebrahim Bagheri and Hossein Deldari[6] describes that genetic algorithm is the search method which is used for solving the optimization problems. Parallel versions of the genetic algorithms are easily implemented and increases the performance of the algorithm[7]. In this paper authors propose a new method for fuzzy parallel genetic algorithms, in which a parallel client server single population fuzzy genetic algorithm is configured to optimize the performance of the first three DeJong functions in order to reach a global solution in the least possible iterations[7]. Rakesh et al[8] describes that genetic algorithm can be used for the number of NP hard problems such as dejong function, travelling salesmen problem(TSP), etc. This paper describes that the performance of the genetic algorithm can be improved by adding the local seach in any phases of the algorithm. In this paper performance of the genetic algorithm is observed. Zhang fang, Li na and Li jinhui[9] focuses design and realization of the test paper composition model that is established and chromosome encoding method of test paper composition, adaptability function and genetic operator. This paper basically describes the test composition of the algorithm. Meera kapoor and vaishali vadhwa[10] introduced to maximize or optimize dejong’s function1 in genetic algorithm using roulette wheel selection, rank selection, tournament selection and random selection. In this paper authors applied for the maximization value in real encoding and for that they uses the different types of crossover methods for producing the better offsprings’. in this paper mutation is used for the implementation of the algorithm. After the experiment and the implementation results came out and that result describes that the best selection method is the roulette wheel selection. This selection technique is the probability based selection technique. Jadaan et al. [11] for example compared the results of GA between proportional roulette wheel and rank-based roulette wheel selection method using several mathematical fitness functions and found that rank-based outperformed proportional in number of generations to come out with the optimal solution. He observed that rank-based is steadier, faster, certainty and more robust towards the optimum solutions than proportional roulette wheel. On the other hand, Zhong et al. [12] compared proportional roulette wheel with tournament selection, with tournament size equal 6 at seven general test functions and concluded algorithm with the tournament selection is more efficient in convergence than proportional roulette wheel selection.

### III. PROBLEM FORMULATION

In this section we describe different dejong functions that are taken for implementation. These are:

A. **Dejong Function1 (Sphere Model):**

This is the first function of dejong as sphere model. Sphere model is smooth, strongly convex. Sphere model is a unimodal.

\[
 f_1(x) = \sum_{i=1}^{n} x_i^2 - 5.12 \leq x_i \leq 5.12
\]

Global minimum : \( x_i = 0 \quad f(x) = 0 \)

B. **Axis Parallel Hyper-Ellipsoid:**

The axis parallel hyper-ellipsoid is similar to DeJong’s function 1. It is also known as the weighted sphere model. Again, it is continuous, convex and unimodal.

\[
 f_2(x) = \sum_{i=1}^{n} x_i^2 - 5.12 \leq x_i \leq 5.12
\]

Global minimum : \( x_i = 0 \quad f(x) = 0 \)

C. **Rastrigin Function:**

This function is based on function 1(sphere model) with the addition of cosine modulation to produce many local minima[13]. Thus, the test function is highly multimodal. However, the location of the minima is regularly distributed.

Function definition:

\[
 f_6(x) = 10n + \sum_{i=1}^{n} [1 - \cos(2\pi x_i)] - 5.12 \leq x_i \leq 5.12
\]

Global minimum: \( F_6(x)=0, x(i)=0, i=1 \) to \( n \)

### IV. SELECTION METHODS USED IN DEJONG FUNCTION

Two selection methods are used in this paper to implement the dejong function (Dejong function1, Axis parallel hyper-ellipsoid, Rastrigin function). These are described as follows:

A. **Rank Selection Approach:**

In this module, the rank selection is been included as the selection algorithm in the basic genetic model. In case of rank selection approach, the population individuals are arranged in a sorted order. On this ordered dataset, the rank based selection is performed by using the following formula.

\[
 P_i = \frac{1}{N} ((P_{worst} + (P_{best} - P_{worst}) \ast ((I-1) / (N-1)))
\]

Here, \( P_{worst} \Rightarrow \) Worst Fit Individual
\( P_{best} \Rightarrow \) Best Fit Individual
\( N \Rightarrow \) Size of Population
\( I \Rightarrow \) Population Individual

The rank selection algorithm based genetic algorithm to optimize the Coverage of DeJong Algorithm is given as under.

1) Create an initial generation of population using Dejong function (Dejong function1 or Axis parallel hyper-ellipsoid or Rastrigin function).
2) Define the Minimization based Fitness Rule over the population.
3) Select the top-ranked rule and calculate its fitness over the selection period. Save it as the initial best rule.
4) Randomly select two rules, using weights attaching higher probability to more highly ranked rules.
5) Measure the fitness of each rule in the new generation over the training period. Take the best rule in the training period and measure its fitness over the selection period. If it outperforms the previous foremost rules, save it as the new optimal rule.
B. Roulette Wheel Selection Approach:
Roulette Wheel is the classical and effective selection operator described by Goldberg. According to this approach, the member pool is defined based on a roulette wheel proportional model to determine the fitness value. Higher probability values will have the highest chances of selection. According to this method, the chance of the individual selection is proportional to the fitness value of individual. It means the individual with higher fitness will be selected more often. The basic work of this method is summarized her as.
1) Some of the finesses of all the population members; call the result total fitness.
2) Generate n, a random number between 0 and total fitness
3) Return the first population member whose fitness, added to the fatnesses of the preceding population members, is greater than or equal to n.

V. IMPLEMENTATION AND OBSERVATION
In this paper dejong function1, Axis parallel hyper-ellipsoid, Rastrigin function is implemented by using the matlab code. Dejong[14] gives the five test function in 1975. Dejong functions are also used as the evaluation functions in the genetic algorithm. These are also called as the benchmark functions. Dejong invent these functions when he is doing his thesis. Dejong gives many functions; In this research we use dejong function1 (Sphere model), Axis parallel hyper-ellipsoid, Rastrigin function. In this research two selection methods (roulette wheel selection and rank selection) are compared. By using these two selection operators de Jong functions are implemented as:

A. Dejong Function1:
\[ f_1(x) = \sum_{i=1}^{n} x_i^2 \quad -5.12 \leq x_i \leq 5.12 \]

\[ X \rightarrow \text{represents generation number} \]
\[ Y \rightarrow \text{represents minimum value of generation at X for selection} \]

<table>
<thead>
<tr>
<th>No of generation</th>
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<th>Rank selection</th>
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<tr>
<td>150</td>
<td>63</td>
<td>5.671</td>
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Table 1: Represents Minimum Values Of Different Selection At Different Generations

B. Axis Parallel Hyper-Ellipsoid:
\[ f_2(x) = \sum_{i=1}^{n} x_i^2 \quad -5.12 \leq x_i \leq 5.12 \]

\[ X \rightarrow \text{represents generation number} \]
\[ Y \rightarrow \text{represents minimum value of generation at X for selection} \]

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Table 2: Represents Minimum Values Of Different Selection At Different Generations
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C. Rastrigin function:

\[ f(x) = 10n + \sum_{i=1}^{n} [x_i^2 - 10 \cos (2 \pi x_i)] - 5.12 \leq x_i \leq 5.12 \]

X → represents generation number
Y → represents minimum value of generation at X for selection

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Table 3: Represents Minimum Values of Different Selection at Different Generations

VI. CONCLUSION & FUTURE SCOPE

In this paper two types of selection strategy (i.e. roulette wheel and rank) are used in genetic algorithm to solve three dejong functions (i.e. sphere model, Axis parallel hyper-ellipsoid function, Rastrigin function). In this paper values of both these selection schemes are compared which are represented by the table. By doing this we found that the rank selection gives better results than roulette wheel selection. All the results are shown with the help of graphs which describe that the rank selection gives better results. Results are compared for 50 generation, 100 generation and 150 generation. After calculating the results it is concluded that the results of rank selection in every generation is better than roulette wheel selection. In future we can use different problem other than dejong function and calculate the results using these selection strategies. And also researchers can use different dejong functions and calculate the results using different selection methods.

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